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Cette recherche est la deuxième étape d'un projet qui avait pour but d'expérimenter un module de mathématiques spécialement conçu par le conseiller Don Reid pour apprendre à résoudre des problèmes. Après six mois d'expérimentation en 5e année, trois groupes d'élèves ont participé à l'évaluation : un groupe expérimental composé d'élèves qui avaient participé au projet l'année précédente, un groupe expérimental composé d'élèves qui n'avaient pas été exposés à la méthode auparavant et un groupe témoin. Les résultats indiquent que le module a été bien accueilli et qu'il a été utilisé plus efficacement par ceux qui en avaient déjà profité l'année précédente.

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Development, Implementation and Evaluation

of

A Module Design to Improve Problem Solving Skills

Grade 6

Ellen Adiv

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A number of people contributed to the realization of this project. I would like to express my gratitude to Joan Fitzpatrick, Consultant Inner City Schools and Sharon Browman, Elementary Consultant Inner City Schools, who provided valuable input during the planning stages of the project and who helped coordinate many of the activities that took place. Special tribute is due to Don Reid, Mathematics Consultant at the P.S.B.G.M. who developed the pedagogical guide, conducted the workshops and closely followed the implementation of the module in the classroom. Sincere thanks go to Jodi Boltuc, my research assistant, who helped with every facet of the evaluation. Last but not least, I would like to express my appreciation to the principals, the teachers and the pupils of the participating schools for their collaboration.

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Résumé

Cette recherche constitue la deuxième étape d'une étude qui vise à développer et à évaluer un outil pédagogique dans le but d'améliorer les habiletés nécessaires pour résoudre les problèmes en mathématiques.

La réalisation du projet s'est faite en quatre étapes: (1) élaboration d'un guide pédagogique, (2) entraînement des professeurs, (3) expérimentation dans la classe et (4) évaluation. Cette année l'outil pédagogique a été introduit au niveau de la 6e année et l'expérimentation a duré six mois.

Trois groups d'élèves ont participé à l'évaluation du projet: (1) un groupe expérimental (Ex_1) composé d'élèves qui avaient participé au projet l'année précédente, (2) un groupe expérimental (Ex_2) composé d'élèves qui n'avaient pas été exposés à l'outil pédagogique auparavant et (3) un groupe d'élèves témoins (Co).

L'efficacité de l'outil a été évaluée à l'aide de deux tests en mathématiques et d'un questionnaire qui ont été administrés à tous les élèves. De plus, on a demandé aux professeurs de remplir un questionnaire qui élicitait des

informations concernant leurs réactions à cet outil pédagogique. Ce questionnaire a été administré à la fin de la période d'expérimentation.

Les résultats de l'évaluation indiquent que: (1) avant l'introduction de l'outil pédagogique dans la classe (pré-test) le groupe Ex_1 a obtenu des résultats nettement supérieurs à ceux du groupe Ex_2 et à ceux du groupe Co, à deux mesures d'évaluation portant sur l'emploi des stratégies de résolution de problèmes. (2) A la fin de la période d'expérimentation (post-test) les deux groupes expérimentaux ont obtenu des résultats nettement supérieurs à ceux du groupe témoin à toutes les mesures d'évaluation des tests en mathématiques. Entre le groupe Ex_1 et le groupe Ex_2 il n'y avait pas de différence significative à la plupart de ces mesures. Cependant le groupe Ex_1 diffère du groupe Ex_2 en ce qui concerne le genre de stratégie dont les élèves se servent le plus souvent. (3) Le rendement des deux groupes expérimentaux s'est nettement amélioré du pré-test au post-test tandis que chez le groupe témoin il n'y a pas eu de changement significatif. (4) Les réactions des professeurs envers l'outil pédagogique ont été très positives. (5) Le taux de participation des élèves aux travaux de classe a été très élevé.

Les résultats de cette étude indiquent aussi que l'effet de l'outil pédagogique sur le développement des habiletés nécessaires pour résoudre les problèmes en mathématiques a été beaucoup plus fort cette année que pendant l'étape précédente du projet. Ceci nous mène à conclure que l'efficacité de l'outil pédagogique dépend largement de la durée de l'expérimentation dans la classe.

Summary

This study constitutes the second phase of a project designed to develop, implement and evaluate a module for the improvement of problem solving skills.

The project consisted of four stages: (1) development of a pedagogical guide, (2) training of the teachers, (3) implementation of the module in the classroom and (4) evaluation. This year the module was implemented in grade 6 during a six-month period.

Three groups of students participated in the evaluation: (1) a group of experimental students (Ex_1) who had already participated in Phase I of the project, (2) a group of experimental students (Ex_2) who had had no prior exposure to the module and (3) a group of control students (Co).

Two mathematics tests and an attitudinal questionnaire were administered to all the students. A questionnaire designed to elicit information about the reactions of the teachers to the module was administered to the latter at the end of the implementation period.

The results of the evaluation indicate that: (1) prior to the implementation of the module (pre-test), the Ex_1 group scored significantly higher than the Ex_2 group and the Co group on measures pertaining to the use of problem solving strategies.

(2) At the end of the implementation period (post-test), both experimental groups scored significantly higher than the control group and there were practically no significant differences between the Ex_1 group and the Ex_2 group on any of the variables measured by the mathematics tests. However, the two experimental groups differed from one another in the type of strategy they most frequently used. (3) The performance of the two experimental groups improved significantly between the two testing periods and no such change was noted for the control group. (4) The teachers' reaction to the module was very positive. (5) Student involvement during the classroom sessions was very high.

The outcome of the evaluation also shows that the impact of the module on the development of the students' problem solving skills was much more pronounced this year than during the previous phase of the project. The findings lead to the conclusion that the effectiveness of the module is largely dependent on the time span during which it is implemented in the classroom.

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Over the past decade, the need to improve the teaching of problem solving skills has been increasingly emphasized by those concerned with mathematics education at all levels of elementary and secondary schooling. The difficulty students experience with problem solving has been well documented (see, for instance, Avital and Shettleworth, 1968; Carpenter et al. 1980; Ross and Maynes, 1982; Sherrill, 1983). The issue is particularly acute in Inner City schools where low achievement in mathematics is wide-spread.

To address this issue, the Protestant School Board of Greater Montreal (P.S.B.G.M.) has developed a special module designed to enhance the development of problem solving skills. The module was introduced during the 1985-1986 school year into the grade 5 classes of several Inner City schools and was expanded the following year to the grade 6 classes. This report describes the entire project and focuses on the outcome of the 1986-1987 evaluation of the module.

Educational Theories and the Teaching of Problem Solving

The issue of how to best teach the skills related to problem solving has been spurred by the growing awareness that neither the behavioristic approach to the learning of mathematics, which

focused on imitation and repetition, nor the much broader "Modern Mathematics" approach, which emphasized content over drill, seem to provide students with effective tools for problem solving (see, for example, Branca, 1980; Fennel, 1981, Avital, 1983; Chisko, 1985). It has been argued that one of the reasons for the students' failure to develop problem solving abilities is the continued stress of product over process.

In addition, changes in the general philosophy of education have contributed to the realization that learning contexts must be set up in a way so as to maximalize opportunities for exploration and discovery on the part of the learner. When these notions are applied to the teaching of problem solving, they translate into a series of steps which involve thinking skills in the broadest terms. The activities used to direct these skills towards the solving of mathematical problems result in the acquisition of what has been termed problem solving strategies (Charles and Lester, 1982; Lester, 1983).

The most dramatic change in the instructional approach to problem solving is the shift from product oriented techniques to a process oriented methodology. In other words, the focus has been transferred from the final answer to the problem to those intermediate

stages which lead to the formulation of a plan for the solution of the problem (Schoenfeld, 1980; Kantowski, 1981). The various aspects of this new orientation have been described in a previous report (Adiv, 1981). They are included here for the benefit of readers who may not have read that report.

New Instructional Approaches

The shift in emphasis from product to process has several implications. First of all, it necessitates the identification of the steps involved in arriving at the solution of a problem. Polya's (1957) model is perhaps the most widely adapted model for this purpose. According to Polya, problem solving involves four basic steps:

- understanding the problem
- devising a plan (for its solution)
- carrying out the plan
- checking the answer

This four-step model is not new. Unfortunately, all too often the scope accorded to each step, particularly steps one and two, is much too narrow. Understanding, for instance, is frequently limited to simply comprehending the written text. Carpenter et al. (1980) found that many students read a problem

and immediately attempt to calculate the answer by using the given numbers in a simple mathematical operation. Lester (1975) noted that students often misread and misinterpret problems, thus, failing to coordinate the multiple conditions that make up the problem. As Polya (1957) sees it, understanding involves grasping the entire network of relationships that holds between the factors stated in the text.

Similarly, Polya's second step, namely planning how to solve the problem, is frequently equated with merely choosing a mathematical operation, at least at the elementary level. This oversimplification may be due, to some extent, to the nature of the problems which are presented in most mathematics books (Carpenter et al. 1981). Indeed, the findings of the second National Assessment of Educational Progress (reported in Carpenter et al.) clearly show that students are markedly more successful at solving routine one-step problems than problems that involve some kind of deeper analysis. Kantowski (1981) claims that these one-step problems are little more than a number exercise stated in verbal form. Even when the problems are of a more complex nature, the instructional procedure followed in presenting these problems is essentially the same. In most cases, the teacher gives a sample problem and explains the steps to be followed in

order to arrive at the solution. This sample problem then becomes a model which the students use to solve other similar problems. Dessart (1981) argues that although this procedure provides learners with some guidance, it is primarily a "matching-analysis procedure" which does not motivate the learner to think the problem through (p. 11).

Today, mathematics educators propose that students be exposed to problems for which they have no readily applicable model. To find the solution to this type of problem, learners have to have recourse to a variety of discovery techniques some of which are not necessarily related to mathematics. According to Schoenfeld (1980) such discovery techniques involve heuristic processes which can vary from one individual to another. The central function of heuristics is to help problem solvers "approach, understand and/or marshall their resources to solve problems." (p.432).

The introduction of heuristics into the classroom is still in its infancy. The task is a difficult one since its key component involves the coordination between prior experience, creativity and an in-depth understanding of the problem that is to be solved. In order to encourage students to apply heuristic procedures to problem solving, Charles and Lester (1982)

propose to teach students a number of strategies starting as early as grade 3. Most of the strategies provide the learner with a visual representation of the relationship that holds between the factors given in the problem, e.g., draw a picture or find a pattern. Others appeal to logic (use logical reasoning) and to common sense, e.g., guess and check. In addition, the authors state several conditions which they think will help students become better problem solvers. First, the problem must be sufficiently interesting to the students so that they will want to solve it. Second, the problem must be appropriate to the students' prior experience in mathematics, to their reading ability and to their analytical ability. Finally, affective factors such as tolerance for ambiguity, perseverance, and the level of anxiety the learner experiences also influence success in problem solving. Their advice to teachers is to devote a serious amount of time to problem solving distinct from other instructional time assigned to mathematics. They also put much emphasis on a positive classroom climate, one which is challenging without being frustrating, a setting where the emphasis is on the search for a solution rather than on getting the correct answer.

Other guidelines for a successful problem solving program suggest that students be encouraged to discuss the problem and

propose ways to solve it before they actually work out the answer (Lester, 1983). Moreover, in order to show a student that problems can be solved in more than one way, teachers should reward risk takers and accept unusual soluctions.

To meet the challenges of this new instructional approach, two basic needs have to be met: teachers must be adequately prepared for their task and appropriate teaching materials must be developed. Most of the textbooks currently in use put little emphasis on how to actually teach problem solving. Wearne (1981) notes:

> "Redesigning textbooks so they develop understanding and involve students in problem solving activities is more than a cosmetic change of including a few additional changes in a book". (p. 40)

The teaching module that is described in this project was developed with these issues in mind.

The Project

The Problem

The difficulties children experience with problem solving has

also been a matter of concern in the P.S.B.G.M. schools, particularly the Inner City schools. An analysis of the results of the mathematics tests administered in all the schools reveals that the year prior to the development of this project (1984), approximately three fourths or 75% of the items pertaining to problem solving were answered incorrectly by students in Inner City schools. Further insights into the performance of students in the P.S.B.G.M.'s Inner City schools can be gained from a longitudinal study (Adiv and Dorè, 1985; Adiv and Boltuc, 1986) which examined student achievement in relationship to the socio-economic background of students in both Inner and non-Inner City schools. The findings of the study indicate that students from socio-economically disadvantaged homes scored consistently lower on problem solving tasks than students from less disadvantaged homes who attended the same classes.

Since the majority of the students in Inner City schools come from socio-economically disadvantaged homes, it was decided that there was a real need in these schools for some kind of program that would focus specifically on problem solving.

Purpose of the Project

The purpose of this project was to design, implement and evaluate a module designed to improve problem solving skills. In keeping with the present-day notions on how to help students

develop better problem solving skills, it was decided to focus on process problems and to use an instructional approach that would expose the learner to some of the problem solving strategies discussed by Charles and Lester (1982). The module was designed for the upper elementary grades. It was felt that the introduction of such a module at these grade levels would ensure that the students were cognitively mature enough to handle the material.

The project was carried out in two phases. Each phase consists of four parts: (1) the development of a pedagogical guide, (2) the training of the teachers, (3) the implementation of the module in the classroom and (4) the evaluation. Each of these parts is discussed below.

(1) The Pedagogical Guide

The pedagogical guide was developed by Don Reid, Mathematics Consultant at the P.S.B.G.M. It provides the teacher with a short introduction to the issues on teaching problem solving in the classroom and then goes on to present the following seven strategies proposed by Charles and Lester (1982):

(1) Draw a picture

(2) Make a table

(3) Make an organized list

(4) Ask intermediate questions

(5) Guess and check

(6) Find a pattern

(7) Use logical reasoning

Each strategy is explained by means of one or two examples and is followed by several problems which can be solved by applying that particular strategy.

Furthermore, Mr. Reid suggests using Polya's four step model (1965) whenever possible. He also recommends a number of additional guidelines such as asking students questions and having them explain how they derived their solutions.

On the last page of the guide, the teacher is provided with a number of references for resource material.

Two versions of the guide are presently available. The first one was developed for Phase I of the project (1985-1986). The second one is an expansion of the original version and was prepared for Phase II of the project (1986-1987). It should be noted that both versions are designed to complement the workshops and neither is a handbook for use in the classroom.

(2) Training of the Teachers

In order to prepare teachers to use a strategy oriented

instructional approach, a three-day workshop was given a short time prior to the time the module was to be introduced into the classroom. Each day's session was divided into two parts: a formal work period and an informal work period. The entire workshop was organized by Don Reid who also led the formal sessions. Using the pedagogical guide as a base, Mr. Reid briefly introduced the teachers to the notion of process problems and then proceeded to discuss the strategies, letting the teachers work out for themselves the additional problems given in the guide.

In addition to the pedagogical guide, the teachers were provided with a variety of problem solving resource materials for use in the classroom and additional reference reading to broaden their scope of knowledge on the topic. The informal afternoon sessions were used to examine these materials, hold small group discussions and plan how to introduce this new approach to problem solving into the classroom.

Part of each day's formal session was devoted to questions that arose out of the work the teachers had done on their own during the previous day. Mr. Reid also made a number of suggestions pertaining to the procedures teachers should use in the classroom. In particular it was noted that the sessions should not be labeled as problem solving lessons and that they should be organized so as

to actively involve the students in discussions.

With respect to the actual teaching of the strategies, two approaches were presented. Teachers could either work on many problems using the same strategy for a certain time and then go on to the next strategy (matched approach) or they could use different types of problems right from the beginning and each time apply the strategy that fits best to a given problem (unmatched approach). Other procedures pertaining to the implementation of the module such as classroom activities, choice of materials and time allocations were left open-ended so as to give each teacher maximum flexibility to accommodate the module into his or her lesson plan.

Two follow-up activities were undertaken in order to see how teachers were implementing the module in the classroom and to provide further guidance if necessary. The first was a series of classroom observations and the second was a one-day workshop given midway through the implementation period of the module. The follow-up workshop also provided an opportunity for the teachers to share their experiences and to discuss with Mr. Reid questions which had arisen during the time the module was being used.

The workshops, particularly the initial three-day sessions, were very successful. The teachers, who were well aware that their students were not acquiring satisfactory problem solving skills through the conventional methods, were eager to try new approaches. Moreover, they were grateful for the opportunity to broaden their own horizons. They found their actual participation in the problem solving tasks a stimulating experience and they enthusiastically prepared themselves to extend this experience to their own classrooms.

(3) Implementation of the Module in the Classroom

During Phase I of the project (1985-1986), the module was implemented at the grade 5 level during a three-month period (February - April, 1986). The following year (Phase II) it was implemented at the grade 6 level during a six-month period (November 1986 through April 1987).

Each of the teachers introduced the module in his or her own way. There were, however, a number of common features which characterized the learning experience these teachers created for their students. First of all, many teachers, particularly those who took part in Phase I of the project, did not refer to the sessions as problem solving lessons. Instead, labels such as "Brain Teasing" and "Brainstorming"

were often used. These labels were very representative of what was happening in the classroom. Mr. Reid noted during his visits that a teacher would present a problem on the board and then a vivid discussion would follow to see how the problem could best be solved. If the teacher was using the problem to introduce a new strategy, he or she would usually lead the discussion and then demonstrate the strategy on the board. On the other hand, if the problem required the application of a strategy which had already been taught, he or she would let the students suggest as many ways of solving the problem as they could think of. The teacher would then let some of the children demonstrate their solutions on the board and discuss with them the different strategies that had been put into use.

Often a teacher would let the students do their brainstorming in small groups and would then discuss with them both the correct and the incorrect solutions. In this way, students were led to examine the reasons that caused certain solutions to be wrong.

Most teachers introduced the strategies one at a time using, in the initial stages, only problems related to that particular strategy (matched approach). However, as soon as

the students had been familiarized with several strategies, teachers found it more challenging to give problems which required the use of different strategies (unmatched approach).

The students' reaction to this new instructional approach was extremely positive. Mr. Reid, who visited the experimental classes several times during the implementation period, found that student involvement was high from the very initial stages of the project. The feed-back received from the teachers during the follow-up workshops confirmed this observation. The teachers also indicated that they felt very comfortable using the strategy approach and that the materials that had been provided during the first workshop had been put to good use. Some teachers noted that their entire perception of how to teach problem solving had changed. However, concern was also voiced as to whether students would apply the problem solving strategies in other contexts, particularly in mathematics. It is precisely for this reason that an assessment of the students' achievement in another area of mathematics was included in the Phase I evaluation of the project.

(4) Evaluation

In order to assess the effectiveness of the module it was decided to measure several aspects of student performance in

mathematics before and after the implementation of the module in the classroom and to compare, at each stage, the performance of these experimental students to that of a control group who was taught the regular mathematics program. The evaluation procedures and results of Phase I of the project have been described in a previous report (Adiv, 1986) and will only be presented in summary form here. Details about the student sample, the test instruments and the outcome of the Phase II evaluation will be described below, following the summary of the previous evaluation.

Summary of Findings from the Phase I Evaluation

In order to assess the effectiveness of the module at the grade 5 level, the students were given a written mathematics test consisting of two subtests (mathematical concepts and problems) from the Canadian Tests of Basic Skills, Level 11 and an oral problem solving task (administered individually). Both tests were administered twice, once as a pre-test and once as a post-test. In addition, the teachers who had implemented the module in the classroom were given a questionnaire to record their evaluation of the new teaching approach they were using.

The results indicate that student performance on the written problem solving test improved significantly between the pre-test and the post-test and the gains made by the experimental group

were more pronounced than those made by the control group. On the other hand, the improvement between pre- and post-test scores on the mathematical concepts test was only marginally significant. Furthermore, there were no significant differences between the pre- and post-test responses on the oral problem solving task. The responses to the teachers' questionnaire show that teacher satisfaction with the module was very high and that teacher training had been adequate. Moreover, the teachers indicated that the students' participation in the problem solving activities was very intense. Nevertheless, 50% of the teachers felt that their students were not making any transfer between what they had learned during the special sessions and their other math work.

This observation may explain why the experimental group's results on the mathematical concepts test did not improve dramatically on the post-test. On the other hand, it is difficult to know why the experimental students' performance on the oral problem solving task did not parallel their performance on the corresponding written test. The answer may, of course, lie in the fact that the oral test attempted primarily to elicit information about the strategies the students were using. It is possible that the students were still too concerned with the final answer and were, therefore, not consciously aware of the strategies they were using. It is also possible that they simply

had not yet acquired the verbal means to explain how they got to that final answer.

Thus, the evaluation of Phase I of the project led to the conclusion that the module had a positive though limited effect on the development of the students' problem solving skills. It was felt that this effect was attributable primarily to the relatively short span of time during which the module had been implemented in the classroom. This hypothesis as well as the teachers' positive reactions to the module prompted the decision to implement the module for a longer period during Phase II of the project.

Phase II

The Sample

Two hundred and fifteen grade 6 students participated in the evaluation. One hundred and forty-nine of them were experimental students and the remainder (66) constituted the control group (hereafter Co group). Among the experimental students, 89 had participated in Phase I of the project (Ex_1 group) and 60 of them had had no prior exposure to the module (Ex_2 group). The students attended eight different Inner City schools and all of these schools belonged to the English sector of the P.S.B.G.M.

The students came from many different socio-linguistic and ethnic backgrounds. Since this feature is a characteristic of most of the P.S.B.G.M.'s schools, it was impossible to hold this variable constant. However, the distribution of the different ethnic groups in the experimental classes was similar to that in the control classes. Moreover, most of the students included in the study had attended an English medium school from kindergarten or grade I and all spoke English fluently.

The Instruments

The instruments used in the evaluation of Phase II of the project differed from those used during Phase I in that they focused in greater detail on the problem solving process. In all, three tests and an attitudinal questionnaire were administered to the students. Two of the tests were mathematics tests and the third was a non-verbal test for the assessment of intellectual development. In addition, a questionnaire was given to the teachers who had implemented the module in the classroom. Each instrument is briefly described below.

The Mathematics Tests

The first mathematics test, hereafter Problem Solving Skills Test or PSST, was developed especially for Phase II of this project. It consists of 15 problems. Each problem is presented in the form of a story and is best solved by using one of the strategies taught

through the module. The problems are printed on different pages of a test booklet, one per page. The rest of the page is left blank in order to provide students with enough space to show how they arrive at the solution. A line at the bottom of the page indicates where the final answer is to be written. Ten of the problems are process problems and the other five are primarily product oriented.

The second mathematics test is a subtest (problems) of the Canadian Tests of Basic Skills (Level 12, Metric version). It consists of 29 story problems and all of them are multiple-choice items.

The Non-Verbal Test

In order to ensure that possible differences between the experimental group and the control group were not due to differences in mental capacity, the students were administered Raven's Standard Matrices test. This test, while not giving a direct measure of IQ, is designed to assess as accurately as possible a person's level of intellectual development. It is particularly suitable for testing children whose mother tongue is not English, since it involves no language skills.

The Student Questionnaire

The student questionnaire was also developed especially

for this phase of the project. It consists of 10 items and elicits information about the students' attitudes to problem solving in general and to the various aspects of problem solving techniques used in the module. In order to assess whether the students' attitudes to problem solving differ from their feelings towards other academic subjects such as language arts and social studies, several questions relating to these topics are included in the questionnaire. All the items are multiple-choice items except the last one which requires a yes/no response and a written explanation of the choice.

The Teachers' Questionnaire

The questionnaire that was administered to the teachers was the same questionnaire that had been used during Phase I of the project. It contains 15 questions and covers four main topics: (1) details about the manner of implementation of the module, (2) adequacy of the training they had received, (3) adequacey of the amount of time allotted to teaching the strategies, and (4) information about student reactions to the project. The teachers are also asked whether they have enjoyed teaching problem solving in this manner and whether they feel the project should have covered more ground. The questionnaire is anonymous to ensure confidentiality.

Administration Procedures

The PSST and the student questionnaire were administered twice, once prior to the introduction of the module into the classroom (pre-test) and once after the six-month period during which the module had been implemented (post-test). The CTBS was administered only once, approximately half-way through the implementation period. The Standard Progressive Matrices Test was administered at the same time as the post-test. The teacher questionnaire was distributed after all the testing had been completed.

All the tests were administered to entire grade 6 classes in all the participating schools (experimental and control groups). However, the test results of students with severe learning problems and those of non-native English speakers who had been in the country for less than two years were later eliminated from the data.

Procedures for the Analysis of the Data

The data from the PSST were analyzed according to two dimensions (1) the strategies used to arrive at the solution of the problems and (2) the actual answers provided. The strategies were rated on a scale going from 3 (appropriate strategy) to 0 (no strategy shown). Answers were given 2 points if they were correct, 1 point if a copying error had occurred and 0 points

if the answer was otherwise incorrect or missing. The strategies as well as the answers were analyzed twice. The first analysis pertained to all the problems included in the test. The second analysis pertained only to the process problems. Moreover, in order to assess to what extent the students were using strategies of the type presented in the module (hereafter problem solving or ps strategies) rather than strategies related to simple mathematical operations, a separate tally was made of the number of times these specific strategies had been used. The data from the CTBS were scored in the conventional way (raw scores and grade equivalents).

The results from the PSST were submitted to a two-way analysis of variance procedure with group (Ex_1, Ex_2, Co) and testing time (pre-test, post-test) as independent variables. A one-way analysis of variance was used to analyze the results of the CTBS and of the Standard Progressive Matrices Test. The data from the student questionnaire did not lend itself to an analysis of variance and a chi square procedure was used here to determine whether the relationship among the three groups had changed significantly over the two testing periods.

The findings of all of these analyses are summarized in Tables 2 - 9 and are briefly described below.

Results

The students' scores on the Standard Progressive Matrices test were analyzed first. The results show no significant differences among the three groups ($F = 0.558$). Thus, there is no reason to believe that differences between the groups on the mathematics tests are attributable to mental capacity.

The Problem Solving Skills Test

The results from the two-way analysis of the PSST scores reveal a significant main effect for testing time (pre vs. post) on all the variables and a main effect for group (Ex_1, Ex_2, Co) on the three variables relating to the strategies the students used in solving their problems (See Table 2). Moreover, there were significant interactions on all the variables indicating that the relationship between the three groups on the post-test differed significantly from that on the pre-test.

Further analysis of the data reveals that the two experimental groups improved their performance markedly between the two testing periods, whereas the increase in the scores of the control group was negligible (see Table 3 for the numerical values of the test scores obtained by each group).

The comparison of the performance of the three groups at

each of the two testing times shows how the gains made by the two experimental groups changed the pattern of relationships among the three groups (see Table 4). On the pre-test, there were no significant differences among the three groups on three of the variables (overall strategies, total number of correct answers and correct answers to process problems). On the other two variables (total strategies used to solve process problems and ps strategies), the Ex_1 group scored significantly higher than both the Ex_2 group and the Co group and there was no significant difference between the latter two groups. In contrast, on the post-test, both experimental groups scored significantly higher than the control group on all the measures of evaluation with the exception of the number of correct answers to the process problems where the difference was only significant between the Ex_2 group and the Co group. On the other hand, there were no significant differences between the two experimental groups on the post-test, except for the total number of correct answers where the scores of the Ex_2 group were significantly higher than those of the Ex_1 group (for the numerical values of the scores see Table 3).

The CTBS

The results from the CTBS, which was administered midway through the implementation period of the module, show that here,

too, the two experimental groups (Ex_1, $\bar{X}$ = 15.44; Ex_2, $\bar{X}$ = 15.79) scored significantly higher than the control group ($\bar{X}$ = 13.24). In terms of grade equivalents, the experimental groups were within a three-month range from the expected grade level, whereas the control group scored as much as seven months below grade level (for numerical values see Table 5).

The Student Questionnaire

The responses to the student questionnaire reveal that the students' attitudes to problem solving as well as to other academic subjects (reading, writing and social studies) were generally very positive with 70% to 80% of them indicating that they liked the activities described in the questionnaire either "very much" or "quite a bit." Moreover, on the pre-test as well as on the post-test, there were no significant differences among the three groups on any of the variables pertaining to problem solving. Nor did the three groups differ significantly from one another in the way the students felt when they could not solve a problem (see Table 6 for the pre-test results and Table 7 for the post-test results). In contrast, there were significant between-group differences in response to the question "Is problem solving fun?" Here, the two experimental groups were considerably more affirmative than the control group. Moreover, markedly more Ex_1 students responded with "yes" on the

post-test (84%) than on the pre-test (71%). The explanations given as to why they thought it was fun were most often comments such as "it makes you use your brain", "it's a challenge" and "it makes you learn new things". The importance of problem solving for some future use was also acknowledged by some. On the post-test, several experimental students noted that "it is fun to work with friends" and "you learn different ways to do things". The negative responses were most frequently explained in terms of the task being "too hard" or "confusing".

With regard to the strategies the students seemed to use most frequently, the following patterns emerged. On the pre-test, there were no significant differences among the three groups in the extent to which the students felt they were using each of the six strategies mentioned in the questionnaire (see Table 8). For three of these strategies (take a guess, find another way, leave the item out), the pattern was similar on the post-test, even though there were proportionally more Ex_1 students who were willing to take a guess (27%) here than there had been on the pre-test (19%). However, on the remaining three strategies (make a table, make a list, draw a picture), the differences among the groups were highly significant on the post-test (see Table 9). First, considerably more experimental students (Ex_1 = 49%, Ex_2 = 52%) than control students (25%) indicated

that they used the "draw a picture" strategy. The experimental students also seemed to make markedly more use of the "make a table" strategy than the control students. The use of this strategy was particularly pronounced with the Ex_1 group (Ex_1= 70%, Ex_2= 48%, Co = 25%). The control group, in turn, favored the "make a list" strategy (Co = 84%, Ex_1 = 63%, Ex_2 = 41%) over the other two strategies.

The Teacher's Questionnaire

The teachers' reactions to the module were very positive. In fact, they gave it a mean rating of 4.5 on the 5 point scale provided in the questionnaire. The teachers indicated that the workshops had been excellent and that the guidance they were given had been sufficient to allow them to feel comfortable in the use of this new approach.

The teachers also felt that their students had enjoyed the work very much (the mean rating on the 5 point scale was 4.0 here) and all but one of them recorded substantial increases in student participation (from an average of 40% at the beginning of the implementation period to 66% towards the end of that period). In fact, in several classes student participation was judged to be as high as 95%. Some of the teachers commented that the new approach had made problem solving much easier for their

students. Others indicated that it had actually turned problem solving into a "fun activity".

Some of the teachers thought that as many as 70% - 80% of their students were applying their newly acquired skills to other math work. On the other hand, slightly over half the teachers felt that only about 40% of their students were transferring what they had learned in the module to other areas of mathematics. Moreover, spill-over to problem solving situations in other subjects was judged to be quite low (34%).

In contrast to the implementation pattern during Phase I, where most of the teachers had set aside a special period for problem solving, during Phase II, practically all the teachers taught the module within the framework of their mathematics lessons. In addition, 60% of them made time for it whenever the opportunity arose. Only three teachers dedicated a special period for these problem solving sessions. Close to two thirds of the teachers noted that the time they had allotted to the teaching of the module was adequate. The others said that the available time span was too short. This difference in reactions seems to be a function of the varying frequencies with which the module was implemented in the classroom. These frequencies ranged from a minimum of once a week to a maximum of three times a week. Two thirds of the

teachers kept the same frequency throughout the implementation period and the others varied the pattern after the first two months.

Classroom Observations

Mr. Reid noted that, as during the previous year, much emphasis was put on group discussion and student involvement was so high in some classes that sometimes the children would not leave the room when the bell rang. Mr. Reid also found that in classes where there were students who had already been exposed to the module in grade 5, the students were generally more perseverant in their efforts to find a solution to their problem. Moreover, the means the grade 6 students devised to solve a problem seemed often better than those given in the textbook. This outcome may be due to the fact that the grade 6 students were cognitively more mature. It is, however, also possible that the longer time span during which the module was implemented in grade 6 had allowed the students to develop more sophisticated brainstorming and argumentation skills. A related point of interest noted by Mr. Reid was that, as time passed, the teacher directed activities such as taking students through a problem step by step decreased and student initiated discussions increased. This was mainly in evidence when a group could not find a solution to a problem they had been assigned. In such cases, group members

would spontaneously involve other students in their discussions, and, thus, new groups were formed without any teacher prompting.

A feature that characterized this year's implementation of the module was the continued stress on the importance of the four basic steps in problem solving. In consequence, the students' discussions centered not only on finding means to solve the problem but also on understanding it fully before attempting to solve it.

In spite of the positive reactions of the teachers and the students to the module, two major weaknesses were noted in its implementation. First, the mode of presentation was not varied enough. Teachers always presented the problems in written form, mostly on stencils or ready cards. Thus there was no opportunity to learn how to deal with a problem when the facts and figures are not presented visually. Second, the final step - checking if the problem had been correctly solved - was not fully exploited. The students were taught primarily to check by retracing their original steps, whereas a comprehensive approach to checking should require the learner to arrive at the same answer through a different path (multiple solution approach). Here again, the mode of presentation should have been broader so as to take students beyond a mechanical routine. A related issue is the extent to which students were given the opportunity to apply their problem

solving skills in areas other than mathematics. Some of the teachers did make use of a problem solving strategy approach in other subjects such as social studies. However, in most classes, this extension of the module was not in evidence. Moreover, there seems to have been no spill-over into real life situations where students often do not know how to handle issues that arise suddenly.

Summary and Discussion

The results of this year's study can be summarized as follows:

1. The teachers' reaction to the module was very positive.
2. Teacher training was reported to have been adequate.
3. Student involvement during the classroom sessions was very high.
4. The two experimental groups were much more positive in their attitudes towards problem solving than the control group.
5. The performance of the two experimental groups improved significantly between the pre-test and the post-test on all the variables measured by the Problem Solving Skills Test (PSST).
6. On the pre-test of the PSST, the Ex_1 group scored significantly higher than the other two groups on two measures related to the use of strategies and there were no other differences among the groups on any of the variables.
7. On the post-test of the PSST and on the CTBS, both experimental groups scored significantly higher than the control group. Between the two experimental groups there was no significant difference except in the case of the total number of correct answers where the Ex_2 group scored significantly higher than

the Ex_1 group.

8. The two experimental groups made significantly more use of the "make a table" strategy and the "draw a picture" strategy than the control group. Moreover, the Ex_1 group used the former strategy much more extensively than the Ex_2 group.

The outcome of this study is very positive in terms of the reactions of the teachers and the students to the module as well as in terms of the improvement of the student's problem solving skills.

With respect to the first point, it is of interest to note that both the teachers and the students noted that the module had provided a context in which problem solving was perceived by the majority of the students as being an enjoyable and challenging activity.

The second point relates more directly to the formal evaluation of the module. Here several noteworthy findings emerged. First, at the time of the pre-test, the Ex_1 students, who had already had some exposure to this instructional approach during the previous year, used significantly more strategies to solve process problems than the other two groups none of whom had had any such exposure at that point. Thus, there seems to

be some evidence here that the skills acquired through this module endure well beyond the actual implementation phase.

Second, once the Ex_2 students were exposed to the module, they rapidly caught up with their peers in the Ex_1 group in the extent to which they used a strategy-based approach to problem solving. However, by the end of the implementation period, a qualificative difference in the use of the strategies emerged between the two groups. The Ex_1 students strongly favored the "make a table" strategy, whereas the Ex_2 students gave equal weight to making tables and drawing pictures. Interestingly, it was precisely this latter strategy which the Ex_1 students had preferred when they were first exposed to the module, i.e., in grade 5. At that point it had been hypothesized that this strategy may be more salient to younger children than the input provided by the other strategies. However, the finding that many of the grade 6 students also favored this strategy suggests that the drawing of pictures may be an easier strategy to grasp and that it may, therefore, represent a natural first step in a learner's attempt to use a strategy-based approach to problem solving. In contrast, the "make a table" strategy may be perceived as more complex since it has a broader range of applications than the "draw a picture" or the "make a list" strategies. Hence, learners may need more time before they start using this strategy with any degree of confidence. Since the Ex_1 students had been

exposed to the module over a two-year period, they would thus be more likely to apply the "make a table" strategy than the Ex_2 students who had only been introduced to the strategy-based approach during the current academic year. It should be noted that the use of a higher level strategy does not necessarily lead to the correct solution of the problem as illustrated by the finding that the Ex_1 group provided, overall, fewer correct answers on the PSST than the Ex_2 group. It is possible that, although many of the Ex_1 students sensed that the use of a table had greater potential than the other strategies, they were not always successful in applying it to actual problem solving tasks. A possible solution to this issue, which has also been proposed by the teachers, would be to introduce the module already in grades 3 or 4 into the classroom.

Finally, the improvement in student performance between the two testing periods (pre and post) was much more pronounced this year than it had been last year. This is probably due to the longer implementation period of the module. Other outcomes of this time factor were greater ability on the part of the students to sustain classroom discussions, to persevere on the task and to consult with friends when in need of help.

Thus, the findings of this year's evaluation suggest that,

if the module is implemented in the classroom for at least two thirds of the academic year, it is beneficial not only in promoting the development of better problem solving skills, but also in providing students with a stronger interpersonal support system as a means to facilitate learning. The gains that can be derived from such a learning experience are, of course, not limited to the problem solving context or even to the mathematics class. In fact, it may be desirable to explore the possibility of using such an instructional approach for the teaching of a variety of academic subjects.

In a similar vein, the concept of learning through problem solving should be implemented on a much broader scale. In fact, it had been hoped that the teachers would provide contexts in other subjects where the use of problem solving strategies could be applied. Unfortunately, there has been little evidence of the realization of this extension of the module. Future projects should address this issue more directly and should study the impact such an approach may have on the learning of subject matter as well as on the development of the students' overall reasoning skills.

REFERENCES

Adiv, E. 1988. Development, implementation and evaluation of a module designed to improve problem solving skills. Inner City Department, The Protestant School Board of Greater Montreal.

Adiv, E. and Doré, F. 1985. Assessment of academic achievement and affective characteristics of pupils from socio-economically disadvantaged backgrounds in Non-Inner City Schools. Inner City Department, The Protestant School Board of Greater Montreal.

Adiv, E. and Boltuc, J. 1986. Assessment of academic achievement and affective characteristics of pupils from socio-economically disadvantaged backgrounds in Non-Inner City Schools, Phase II. Inner City Department, The Protestant School Board of Greater Montreal.

Avital, S. 1983. Teaching for effective problem solving: A challenging problem. In M. Zweng, T. Green, J. Kilpatrick, H. Pollak and M. Suydam (eds.) Proceedings of the Fourth International Congress on Mathematical Education. Boston: Birkhauser Inc.

Avital, S. and Shettleworth, S. 1968. Objectives for Mathematics Learning. Toronto: The Ontario Institute for Studies in Education.

Branca, N.A. 1980. Problem solving as a goal, process, and basic skill. National Council of Teachers of Mathematics Yearbook, vol. 45.

Carpenter, T.P.; Corbitt, M.K.; Kepner, H.S.; Lindgrist, M.M.; and Reys, R.E. 1980. Implications of the second NAEP mathematics assessment: elementary school. Arithmetic Teacher, vol. 27/8, 10-14 and vol. 28/1, 8-13.

Carpenter, T.P.; Corbitt, M.K.; Kepner, H.S.; Linquist, M.M.; and Reys, R.E. 1981. National assessment. In E. Fennema (ed.) Mathematics Education Research: Implications for the 80's. Alexandria, Vi.: Association for Supervision and Curriculum Development.

Charles, R.I. 1985. The role of problem solving. Arithmetic Teacher, vol. 32/6, 48-50.

Charles, R.I. and Lester, F. 1982. Problem solving: what, why and how. Palo Alto, California: Dale Seymour Publications.

Chisko, A.M. 1985. Developmental math: problem solving and survival. Mathematics Teacher vol. 78/8, 592-596.

Dessart, J. 1981. Curriculum. In E. Fennema (ed.) Mathematics Education Research: Implications for the 80's. Alexandria, Vi.: Association for Supervision and Curriculum Development.

Fennell, F.M. 1981. Elementary Mathematics: Priorities for the 1980's. Bloomington, Indiana: Phi Delta Kappa Educational Foundation.

Kantowski, M.G. 1981. Problem solving. In E. Fennema (ed.) Mathematics Education Research: Implications for the 80's. Alexandria, Vi.: Association for Supervision and Curriculum Development.

Lester, F.K. 1975. Mathematical problem solving in the elementary school: some educational and psychological considerations. In L. Hatfield (ed.) Mathematical Problem Solving. Columbus, Ohio: ERIC.

Lester, F.K. 1983. Trends and issues in mathematical problem-solving research. In R. Lesh and M. Landan (eds.) Acquisitions of Mathematics Concepts and Skills. New York: Academic Press.

Polya, G. 1957. How to Solve It, 3rd edition. Garden City, N.J.: Doubleday.

Polya, G. 1965. Mathematical Discovery: On Understanding, Learning and Teaching Problem Solving. vol. 2. New York: Wiley.

Ross, J.A. and Maynes, F.J., 1982. Teaching Problem Solving. OISE Press, Informal Series 143. Toronto: The Ontario Institute for Studies in Education.

Schoenfeld, A. 1980. Structure and heuristic behavior variables in teaching. In G.A. Golden and C.E. McLintock (eds.) Task Variables in Mathematical Problem Solving. Columbus, Ohio: ERIC.

Sherrill, J.M. 1983. Solving textbook mathematical problems. The Alberta Journal of Educational Research. XXIX/2, 140-152.

Wearne, D. 1981. Response to National Assessment. In E. Fennema (ed.) Mathematics Education Research: Implications for the 80's. Alexandria, Vi.: Association for Supervision and Curriculum Development.

Table 1

Sample Sizes

Students exposed to module in grades 5 & 6 (Ex_1)	89
Students exposed to module in grade 6 only (Ex_2)	60
Students not exposed to module (Co)	66

Participating Schools

Bancroft	Coronation	Sinclair Laird
Barclay	Guy Drummond	Woodland
Bedford	Lorne	

Table 2

F Ratios for Two-Way Analyses of the PCST Results

	Group	Pre/Post	Interactions
Strategies used	5.14**	75.25***	4.01***
Correct answers	0.06	60.03***	6.78***
Process Problems			
- strategies	14.45***	114.39***	12.90***
- cor. answers	0.50	39.24***	4.77**
- ps strategies	27.04***	235.67***	24.49***

* p<.01
*** p<.001

Table 3

Group Means from the PSST

	Pre-test			Post-test		
	Ex_1	Ex_2	Co	Ex_1	Ex_2	Co
Strategies used (85)[a]	23.56	21.67	21.24	27.90	29.65	22.96
Correct answers (30)	12.70	12.00	12.83	14.97	16.50	13.69
Process Problems - strategies (30)	12.07	9.40	9.51	16.60	17.39	9.44
- cor. answers (20)	5.08	4.96	5.52	7.27	7.96	6.37
- ps strategies (10)	2.18	1.27	1.35	4.66	4.65	1.76

[a] maximum scores in parentheses

Table 8

Graphic Representation of Significant Between-Group[a] Differences on Pre-Test and Post-Test

	Pre-Test	Post-Test
Strategies used	Ex1 - Ex2 - Co	Ex1 Ex2 Co
Correct answers	Ex2 - Ex1 - Co	Ex1 Ex2 Co
Process Problems		
- strategies	Ex1 Ex2 Co	Ex1 Ex2 Co
- cor. answers	Ex1 - Ex2 - Co	Ex1 Ex2 Co
- ps strategies	Ex1 Ex2 Co	Ex1 Ex2 Co

[a] Groups joined by a line differ significantly from one another.

Table 5

Results from the CTBS Subtest

	Means[a]	SD[b]	Maximum	Minimum	GE[c]
Ex^1	15.44	6.00	27.00	5.00	63
Ex^2	15.79	5.82	25.00	4.00	63
Co	13.24	5.25	28.00	6.00	59

$F = 3.57$, $df = 2,202$, $p < .05$

a Maximum Score = 29

b SD = Standard Deviation

c GE = Grade Equivalent

Table 6

Attitudes Towards Problem Solving Tasks

Pre-Test Results

	Ex_1		Ex_2		Co		
	No.	%[a,b]	No.	%	No.	%	χ^2
Like to solve problems on your own?							
- very much	33	39	26	48	34	54	
- quite a bit	32	38	19	35	16	25	4.14
- a little	15	18	7	13	10	16	
- not at all	4	5	1	2	3	5	
Like to solve problems with a classmate?							
- very much	51	61	28	52	28	44	
- quite a bit	20	24	8	15	17	27	10.98
- a little	11	11	15	28	12	19	
- not at all	2	2	1	6	6	10	
Like to discuss how to solve problems?							
- very much	21	25	21	39	25	42	
- quite a bit	37	45	15	28	21	35	8.54
- a little	20	24	15	28	9	15	
- not at all	5	6	1	7	5	8	

Table 6 (cont'd)

Attitudes Towards Problem Solving Tasks

Pre-Test Results

	Ex_1		Ex_2		Co		
	No.	%[a,b]	No.	%	No.	%	χ^2
Is problem solving fun?							
- Yes	59	71	42	78	33	54	
- No	24	29	12	22	29	46	3.10*
How do you feel if you can't solve a problem?							
- angry	54	64	33	61	48	76	
- indifferent	30	35	19	35	14	22	
- happy	1	1	2	4	1	2	4.71

[a] Number of responses varies slightly across items because some students did not respond to all the items

[b] Percentages do not always add up to 100 because of rounding off.

* $p \leq .05$

Table 7

Attitudes Towards Problem Solving Tasks

Post-Test Results

	Ex1		Ex2		Co		
	No.	%[a,b]	No.	%	No.	%	χ^2
Like to solve problems on your own?							
- very much	33	40	24	44	19	34	
- quite a bit	31	38	15	28	20	36	6.96
- a little	16	20	13	24	11	20	
- not at all	2	2	2	4	6	11	
Like to solve problems with a classmate?							
- very much	37	45	24	44	22	39	
- quite a bit	30	36	14	26	19	34	9.13
- a little	14	17	10	19	13	23	
- not at all	1	1	6	11	2	4	
Like to discuss how to solve problems?							
- very much	25	31	15	28	17	30	
- quite a bit	32	39	16	29	16	29	10.10
- a little	20	24	13	24	20	36	
- not at all	5	6	10	19	3	5	

Table 7 (cont'd)

Attitudes Towards Problem Solving Tasks

Post-Test Results

	Ex_1		Ex_2		Co		
	No.	%[a,b]	No.	%	No.	%	χ^2
Is problem solving fun?							
- Yes	69	84	40	76	30	54	15.97***
- No	13	16	13	25	26	46	
How do you feel if you can't solve a problem?							
- angry	55	67	39	72	41	73	2.10
- indifferent	26	31	13	24	14	25	
- happy	1	1	2	4	1	2	

a Number of responses varies slightly across items because some students did not respond to all the items.

b Percentages do not always add up to 100 because of rounding off.

*** $p < .001$

Table 8

Attitudes Towards Problem Solving Tasks

Pre-Test Results

	Ex_1[a]		Ex_2		Co		
	No.[a]	%	No.	%	No.	%	χ^2
Take a guess	16	19	10	19	9	14	
Find another way	59	69	37	69	46	73	0.64
Leave it out	10	12	7	13	5	13	
Make a table[b]	37	44	21	39	17	27	5.89
Make a list[b]	57	68	32	59	47	76	3.63
Draw a picture[b]	37	44	21	39	17	27	7.05

[a] All items on this table required Yes/No answers. Numbers and percentages represent positive responses only.

[b] Items 4, 5, 6 were analyzed independently from one another.

Table 9

Attitudes Towards Problem Solving Tasks

Post-Test Results

	Ex_1[A]		Ex_2		Co		
	No.[A]	%	No.	%	No.	%	χ^2
Take a guess	22	27	9	17	8	14	
Find another way	50	61	36	68	39	70	1.84
Leave it out	10	12	8	15	9	16	
Make a table[B]	57	70	26	49	14	25	26.14***
Make a list[B]	52	63	32	59	47	84	9.25**
Draw a picture[B]	40	49	28	52	14	25	10.28**

A All items on this Table required Yes/No answers. Numbers and percentages represent positive responses only.

B Items 4, 5, 6 were analyzed independently from one another.

** $p < .01$
*** $p < .001$